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DERWENT-WEEK: 199904

TITLE: Catalytic reactor for gas phase chemical reactions - has filter pad providing large filter surface area trapping large quantity of particulate debris without clogging

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BASIC-ABSTRACT:

Catalytic reactor for gas phase chemical reactions comprises (a) a housing extending along an axis from an enclosed first end to an enclosed second end, and having a continuous interior surface, the first end defining an inlet opening for allowing introduction of a gaseous reactant stream to the housing and the second end defining an outlet opening for allowing a gaseous product stream to exit the housing; (b) a bed of catalyst particles disposed within the housing the catalyst particles being catalytically active in the gas phase chemical reaction; (c) a porous support for supporting the bed of catalyst particles within the housing; and (d) a filter, extending across the housing in a plane perpendicular to the axis of the housing and between the catalyst bed and the outlet opening of the housing, for preventing transport of the catalyst particles from the housing in the gaseous product stream.

ADVANTAGE - The reactor filter pad provides a large fitler surface area relative to the cross sectional area of the reactor, is able to trap a relatively large quantity of particulate debris without clogging and is therefore unlikely to impose a large pressure drop across the reactor.

CHOSEN-DRAWING: Dwg.1/3

TITLE-TERMS: CATALYST REACTOR GAS PHASE CHEMICAL REACT FILTER PAD FILTER SURFACE AREA TRAP QUANTITY PARTICLE DEBRIS CLOGGED

DERWENT-CLASS: E36 H04 J04 L03 Q51 X16

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TITLE: CATALYTIC REACTOR FOR GAS PHASE REACTIONS
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ABSTRACT:

CHG DATE=19990617 STATUS=O>A catalytic reactor for gas phase reactions is disclosed. The reactor includes a housing (2), a porous catalyst support plate (14) within the housing (2), a bed of catalyst particles (16) within the housing (2) and a fibrous filter pad (18) extending across the housing (2) to prevent transport of catalyst particles (16) from the housing (2). The filter pad (18) is resistant to clogging and imposes a low pressure drop across the reactor.

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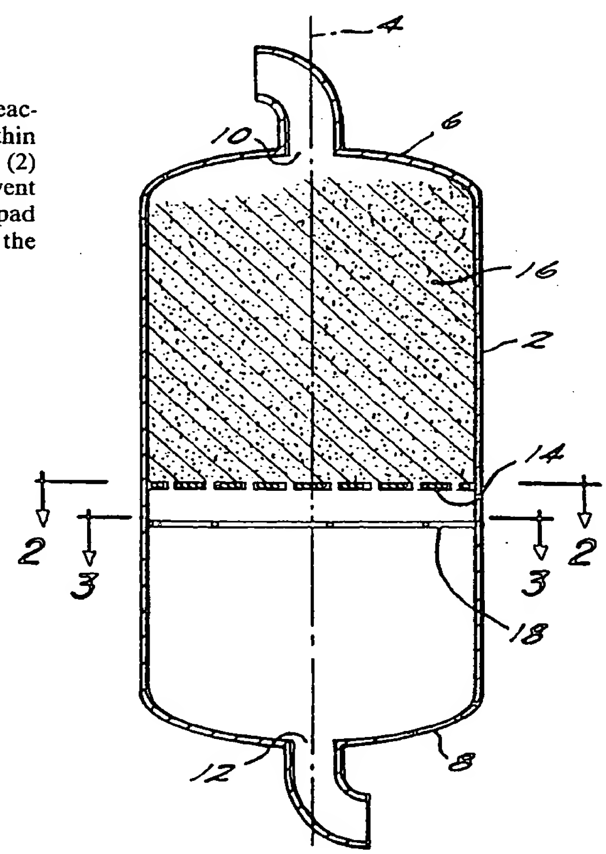
(54) Title: CATALYTIC REACTOR FOR GAS PHASE REACTIONS

(57) Abstract

A catalytic reactor for gas phase reactions is disclosed. The reactor includes a housing (2), a porous catalyst support plate (14) within the housing (2), a bed of catalyst particles (16) within the housing (2) and a fibrous filter pad (18) extending across the housing (2) to prevent transport of catalyst particles (16) from the housing (2). The filter pad (18) is resistant to clogging and imposes a low pressure drop across the reactor.



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Description

Catalytic Reactor for Gas Phase Reactions

Technical Field

The present invention pertains to the art of chemical reactors, and more particularly to the art of catalytic chemical reactors for reforming a hydrocarbon fuel stream to provide a hydrogen fuel stream to a fuel cell.

Background

A fuel cell is a device for converting the chemical energy of a fuel into electrical energy. Fuel cell comprises an anode, a cathode and an electrolyte between the anode and cathode. The anode and cathode each have catalyst layers disposed adjacent to the electrolyte. A fuel stream is electrochemically oxidized at the anode catalyst layer to produce a stream of electrons and an oxidant stream is electrochemically reduced at the cathode catalyst layer. The stream of electrons is conducted from the anode to the cathode through an external circuit. A flow of ions through the electrolyte completes the circuit.

Typically, a hydrocarbon fuel stream is catalytically reformed to provide a hydrogen fuel stream for the fuel cell anode. As a final step in the reforming process, the fuel stream passes through a low

temperature shift converter. The converter contains a bed of copper catalyst particles. If fine copper catalyst particles become entrained in the gas stream and are transported to the fuel cell anode, poisoning of the anode catalyst may result.

In conventional fuel cell power plants, a filter is included in the piping between the shift converter and the fuel cell to trap entrained catalyst particles and prevent transport of catalyst particles from the shift converter to the anode.

Conventional filters may become plugged with catalyst debris thereby imposing a large pressure drop across the system and reducing the flow rate of the fuel gas.

Brief Description of the Drawing

Figure I shows a longitudinal cross section of a catalytic reactor of the present invention;

Figure 2 shows a transverse cross section of the catalytic reactor shown in Figure 1 along line 2-2, and

Figure 3 shows a transverse cross section across the reactor shown in Figure 1 along line 3-3.

Summary of the Invention

A catalytic reactor for a gas phase chemical reaction is disclosed. The reactor includes a housing. The housing extends along an axis from an enclosed first end to an enclosed second end and has a substantially continuous interior surface. The first end of the housing defines an inlet opening for allowing introduction of a gaseous reaction stream to the housing and the second end defines an outlet opening for allowing a gaseous product stream to exit the housing. A bed of catalyst particles is supported within the housing by porous support means. The catalyst particles are catalytically active in the gas

phase chemical reaction. Filter means extend across the housing in a plane perpendicular to the axis and between the catalyst bed and the outlet opening for preventing transport of catalyst particles from the housing in the gaseous product stream. The filter means provide a large filter surface area, is resistant to clogging and is therefore unlikely to impose a large pressure drop across the reactor.

A low temperature shift converter for processing a fuel stream for fuel cell anode is also disclosed as a preferred embodiment of the catalytic reactor described above. In the low temperature shift converter, the catalyst particles are catalytically active in the shift conversion reaction. The filter means prevents transport of the catalyst particles from the housing to prevent poisoning of the fuel cell anode catalyst layer.

Detailed Description of the Invention

Figure 1 shows a catalytic reactor having a right circular cylindrical housing 2 extending along a vertical axis 4, and having an enclosed top end 6 and an enclosed bottom end 8. The enclosed top end 6 defines an inlet opening 10 for allowing introduction of a gaseous reactant stream to the housing 2. The enclosed bottom end 8 defines an outlet opening 12 for allowing a gaseous product stream to exit the housing 2.

A porous catalyst support plate 14 is disposed within the housing 2 and extends across housing 2 in a plane perpendicular to the axis 4 of the housing 2.

A bed of catalyst particles 16 is disposed within the housing 2 and supported on the porous catalyst support plate 14. The composition and particle size of the catalyst particles are chosen according to conventional principles of catalytic reactor design.

converter, the catalyst particles may be copper catalyst particles. The porous catalyst support plate 14 includes a plurality of openings for allowing gas flow though the plate. The openings are smaller in diameter than the lower limit of the range of the nominal particle size of the catalyst particles of bed 16. In a preferred embodiment, the catalyst particles comprise copper supported on zinc oxide and have a nominal particle size range of about 3.0mm to about 6.0mm and the porous catalyst plate 14 includes a plurality of circular openings each having a diameter of about 2.25mm.

A fibrous filter pad 18 is disposed within the housing between the bed of catalyst particles 16 and the outlet opening 12 and extends across the housing 2 in a plane perpendicular to the axis 4 to prevent transport of catalyst particles 16 from the housing 2. The pad 18 provides a filter area that is about equal to the cross sectional area of the reactor housing 2.

The filter pad 18 comprises a pad of woven fibers or a pad of nonwoven fibers. The composition of the fibers is chosen based on the intended reaction conditions within the reactor. In general, ceramic fibers are preferred due to their chemical inertness and refractory properties. Suitable ceramic fibers include silica fibers, alumina fibers, aluminosilicate fibers and mixtures thereof.

The diameter of the fibers and the void volume ot the filter pad are chosen to provide a filter pad that traps particles having a particle size greater than a preselected minimum particle size.

In a prefered embodiment, the fibers have a fiber diameter between about 2 microns and 3 microns, the

fibrous filter pad 18 has a void volume between about 92% and about 98% and the filter pad prevents transport of particles having a particle size greater than about 1.0 micron.

Alternatively, the orientation of the reactor of the present invention may be reversed so that the inlet opening is defined by the bottom end of the reactor and the outlet opening is defined by the top end of the reactor, the catalyst bed is supported by a catalyst support plate and the filter pad is disposed between the catalyst bed and the top end of the reactor.

The tendency of a filter to clog, i.e. impose a flow restriction, is directly related to the surface area of the filter. Other factors being equal, a filter having a large surface area is able to trap a larger quantity of particulate debris without clogging than is a filter having a relatively small surface area.

Unlike conventional small diameter filters installed in process piping that may become clogged with small quantities of particulate debris and thereafter significantly restrict gas flow through the reactor, the filter pad of the reactor of the present invention provides a large filter surface area relative to the cross sectional area of the reactor, is able to trap a relatively large quantity of particulate debris without clogging and is therefore unlikely to impose a large pressure drop across the reactor.

While preferred embodiments have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustrations and not limitation.

What is claimed is:

1. A catalytic reactor for a gas phase chemical reaction, comprising:

a housing extending along an axis from an enclosed first end to an enclosed second end, and having a substantially continuous interior surface, said first end defining an inlet opening for allowing introduction of a gaseous reactant stream to the housing and said second end defining an outlet opening for allowing a gaseous product stream to exit the housing;

a bed of catalyst particles disposed within the housing said catalyst particles being catalytically active in the gas phase chemical reaction;

porous support means for supporting the bed of catalyst particles within the housing; and

filter means, extending across the housing in a plane perpendicular to the axis of the housing and between the catalyst bed and the outlet opening of the housing, for preventing transport of catalyst particles from the housing in the gaseous product stream.

2. The reactor of claim 1, wherein the axis comprises a horizontal axis, the first end comprises a top end, the second end comprises a bottom end and the porous support means is disposed between the catalyst bed and the filter pad.

3. The reactor of claim 1, wherein the axis comprises a horizontal axis, the first end comprises a bottom end and the second end comprises a top end.

4. The reactor of claim 1, wherein the housing comprises a right circular cylinder.

5. The reactor of claim 1, wherein the porous support means comprises a porous plate extending across the housing in a plane perpendicular to the axis of the housing.

6. The reactor of claim 5, wherein the catalyst particles have nominal particle sizes between about 3.0mm and about 6.0mm, the porous catalyst support plate includes a plurality of openings, said openings each having a diameter between 2.0mm and 2.5mm, and wherein said filter means prevents transport of particles having a particle size having a particle size greater than about 1.0 micron.

7. The reactor of claim 1, wherein the filter means comprises a fibrous filter pad.

8. The reactor of claim 7, wherein the fibrous filter pad comprises ceramic fibers.

9. The reactor of claim 8, wherein the ceramic fibers comprise silica fibers, alumina fibers, aluminosilicate fibers or mixtures thereof.

10. The reactor of claim 8, wherein the ceramic fibers have a fiber diameter between 2 microns and 3 microns and the filter pad has a void volume between 92% and 98%.

11. A low temperature shift converter for processing a fuel stream for a fuel cell anode, comprising:

a housing extending along an axis from a first end to a second end, said first end defining an inlet opening for allowing introduction of a gaseous reactant stream to the housing and said second end defining an

and, extending across the housing in a plane perpendicular to the axis of the housing and between the catalyst bed and the outlet opening of the housing, for preventing transport of catalyst particles from the housing in the gaseous product stream to prevent poisoning of the fuel cell anode.

12. The reactor of claim 11, wherein the axis comprises a horizontal axis, the first end comprises a top end, the second end comprises a bottom end and the porous support means is disposed between the catalyst bed and the filter pad.

13. The reactor of claim 11, wherein the axis comprises a horizontal axis, the first end comprises a bottom end and the second end comprises a top end.

14. The converter of claim 11, wherein the housing comprises a right circular cylinder.

15. The reactor of claim 11, wherein the porous support means comprises a porous plate extending across the housing in a plane perpendicular to the axis of the housing.

16. The converter of claim 15, wherein the catalyst particles have particle sizes between about 3.0mm and about 6.0mm, the porous catalyst support plate includes a plurality of openings, said openings each having a

diameter between 2.0mm and 2.5mm, and wherein said filter means prevents transport of particles having a particle size greater than about 1.0 micron.

17. The reactor of claim 11, wherein the filter means comprises a fibrous filter pad.

18. The converter of claim 17, wherein the fibrous filter pad comprises ceramic fibers.

19. The converter of claim 18, wherein the ceramic fibers comprise silicia fibers, alumina fibers, aluminosilicate fibers or mixtures thereof.

20. The converter of claim 18, wherein the fibers have a fiber diameter between 2.0 microns and 3.0 microns and the filter pad has a void volume between 92% and 98%.

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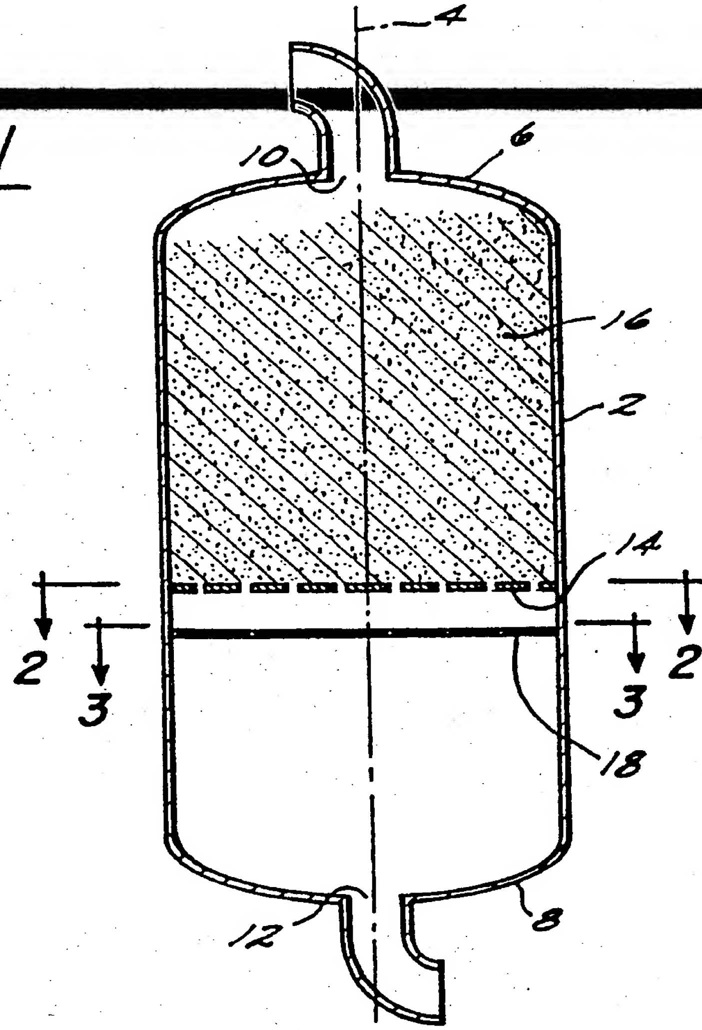
FIG. 1



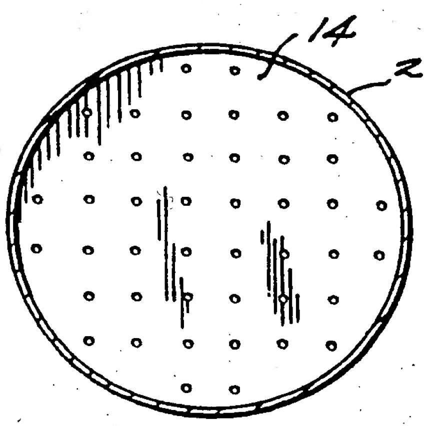


FIG. 2

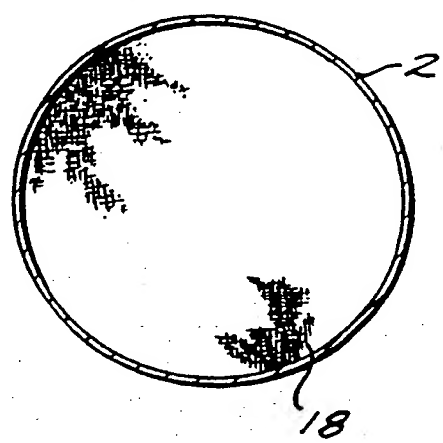


FIG. 3

INTERNATIONAL SEARCH REPORT

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I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): B01D 35/01
U.S. Cl.: 422/177; 422/190; 422/216; 422/239

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
U.S. Cl.	422/177,190,216,239

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	US,A,4,288,409 (FEDDERS ET AL) 08 SEPTEMBER 1981, See column 3, lines 67-68, column 2, lines 44-49	1-20
Y	G. Hawley "The Condensed Chemical Dictionary", published 05 October 1984, by Van Nostrand Reinhold Company (NY), see page 213.	1-20
A	US,A,2,721,788 (SCHAD) 25 October 1955 of general interest.	1-20
A	US,A,3,666,405 (WINSEL) 30 MAY 1972, of general interest	1-20
A	US,A,2,965,936 (KAYE) 27 DECEMBER 1960, of general interest	1-20
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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